US008439789B2

(12) United States Patent
Hart et al.

(10) Patent No.: US 8,439,789 B2
(45) Date of Patent: May 14, 2013

(54) **MULTI-SPEED TRANSMISSION HAVING THREE PLANETARY GEAR SETS**

(75) Inventors: **James M. Hart**, Belleville, MI (US); **James B. Borgerson**, Clarkston, MI (US); **Scott H. Wittkopp**, Ypsilanti, MI (US); **Andrew W. Phillips**, Rochester, MI (US); **Clinton E. Carey**, Highland, MI (US)

(73) Assignee: **GM Global Technology Operations LLC**, Detroit, MI (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 286 days.

(21) Appl. No.: **12/840,918**

(22) Filed: **Jul. 21, 2010**

(65) **Prior Publication Data**

US 2011/0034289 A1 Feb. 10, 2011

Related U.S. Application Data

(60) Provisional application No. 61/231,505, filed on Aug. 5, 2009.

(51) **Int. Cl.**
F16H 3/62 (2006.01)

(52) **U.S. Cl.**
USPC **475/275**; 475/286

(58) **Field of Classification Search** 475/276, 475/286
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,442,969	B1	9/2002	Rojey et al.	
6,626,790	B2 *	9/2003	Raghavan et al.	475/277
6,705,967	B2 *	3/2004	Raghavan et al.	475/275
6,709,360	B2	3/2004	Raghavan et al.	
6,746,358	B2 *	6/2004	Bucknor et al.	475/276
6,945,900	B2 *	9/2005	Usoro et al.	475/276
7,118,508	B2 *	10/2006	Usoro et al.	475/275
7,153,231	B2 *	12/2006	Usoro et al.	475/275
7,226,382	B2 *	6/2007	Bucknor et al.	475/275
7,306,534	B2 *	12/2007	Bucknor et al.	475/275
7,387,585	B2 *	6/2008	Bucknor et al.	475/276
8,016,709	B2 *	9/2011	Wittkopp et al.	475/276
2006/0068966	A1 *	3/2006	Klemen	475/275

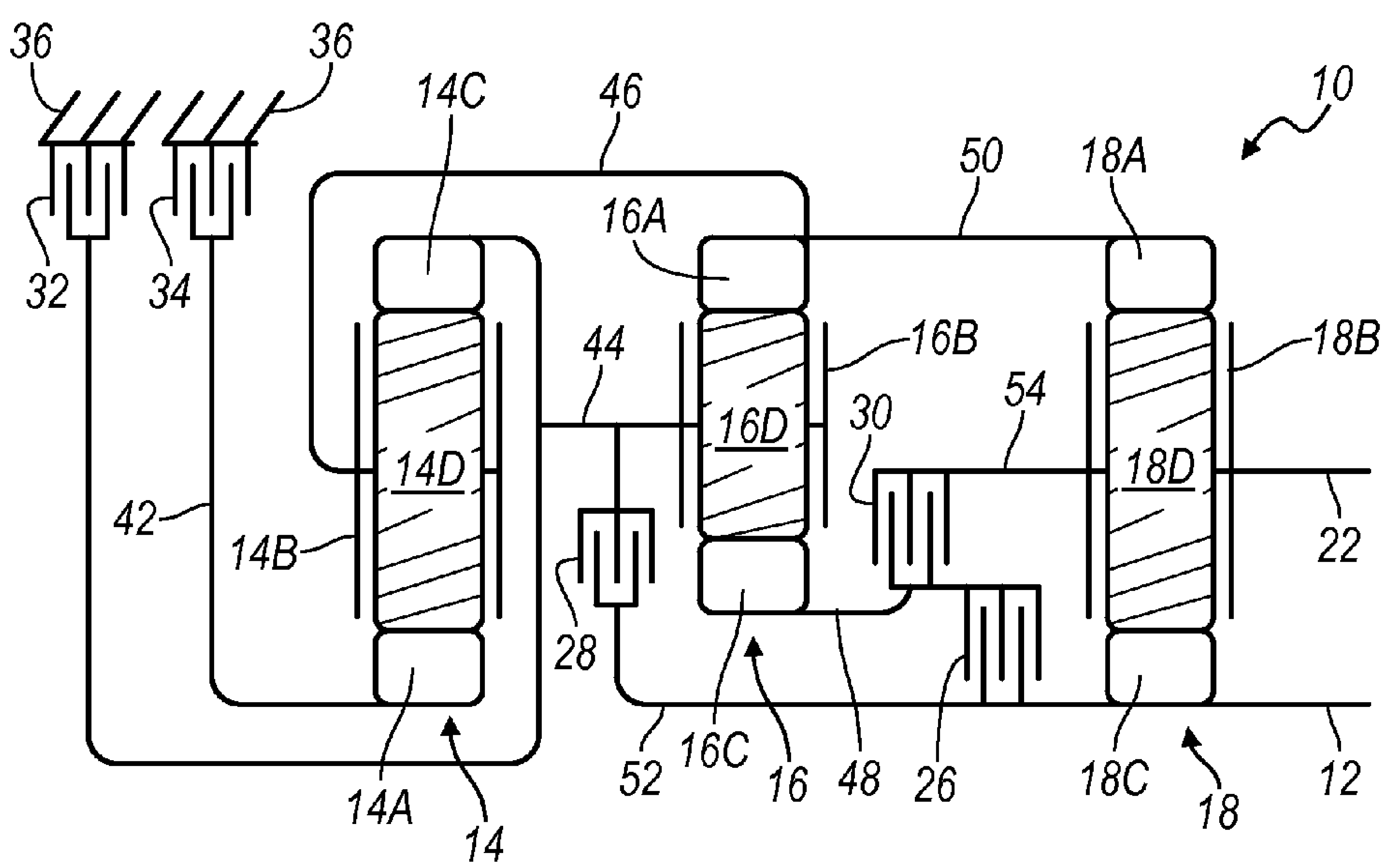
* cited by examiner

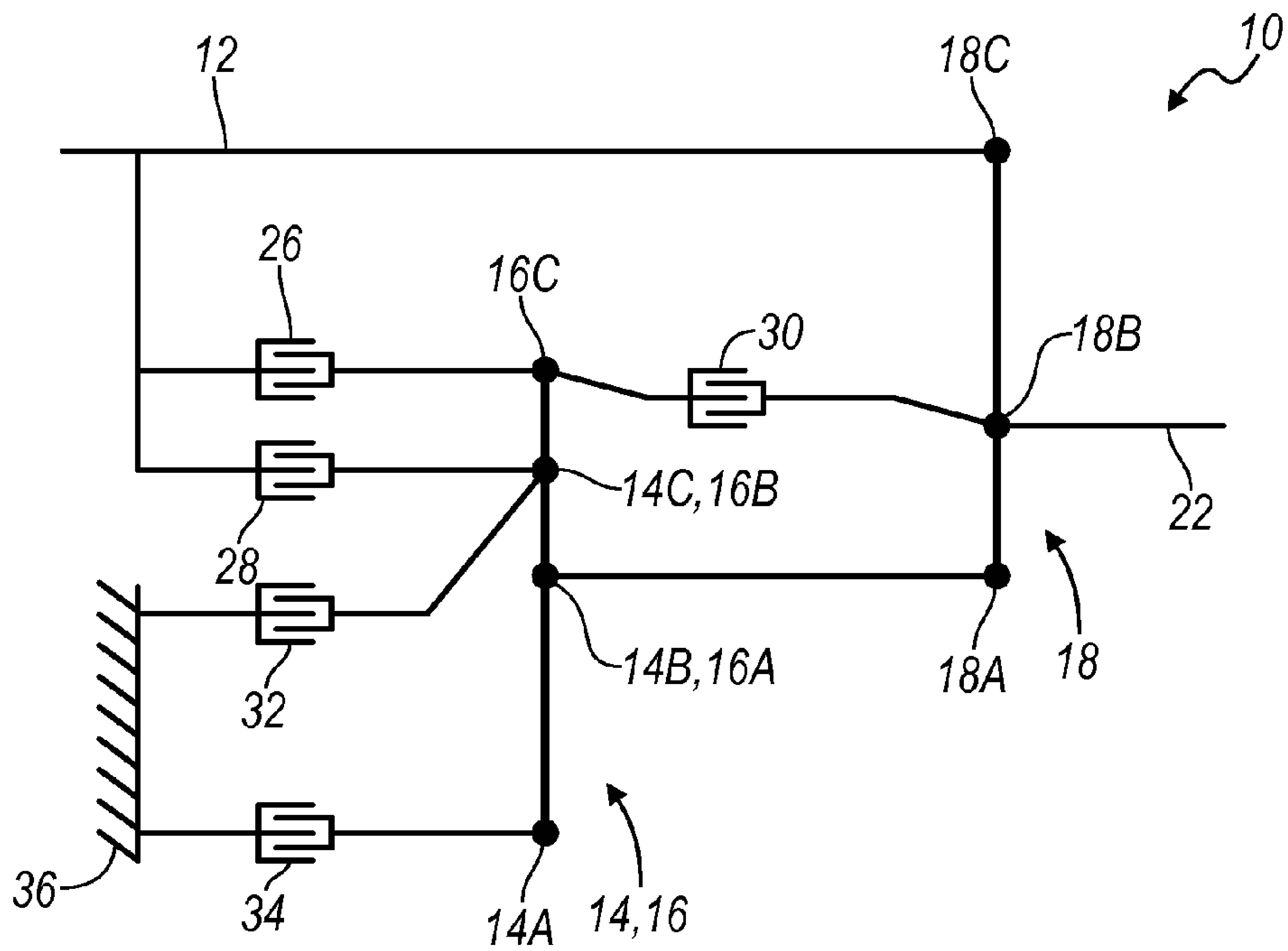
Primary Examiner — Justin Holmes
Assistant Examiner — Jacob S Scott

(57) **ABSTRACT**

A transmission is provided having an input member, an output member, three planetary gear sets, a plurality of coupling members and a plurality of torque transmitting devices. Each of the planetary gear sets includes first, second and third members. The torque transmitting devices include clutches and brakes.

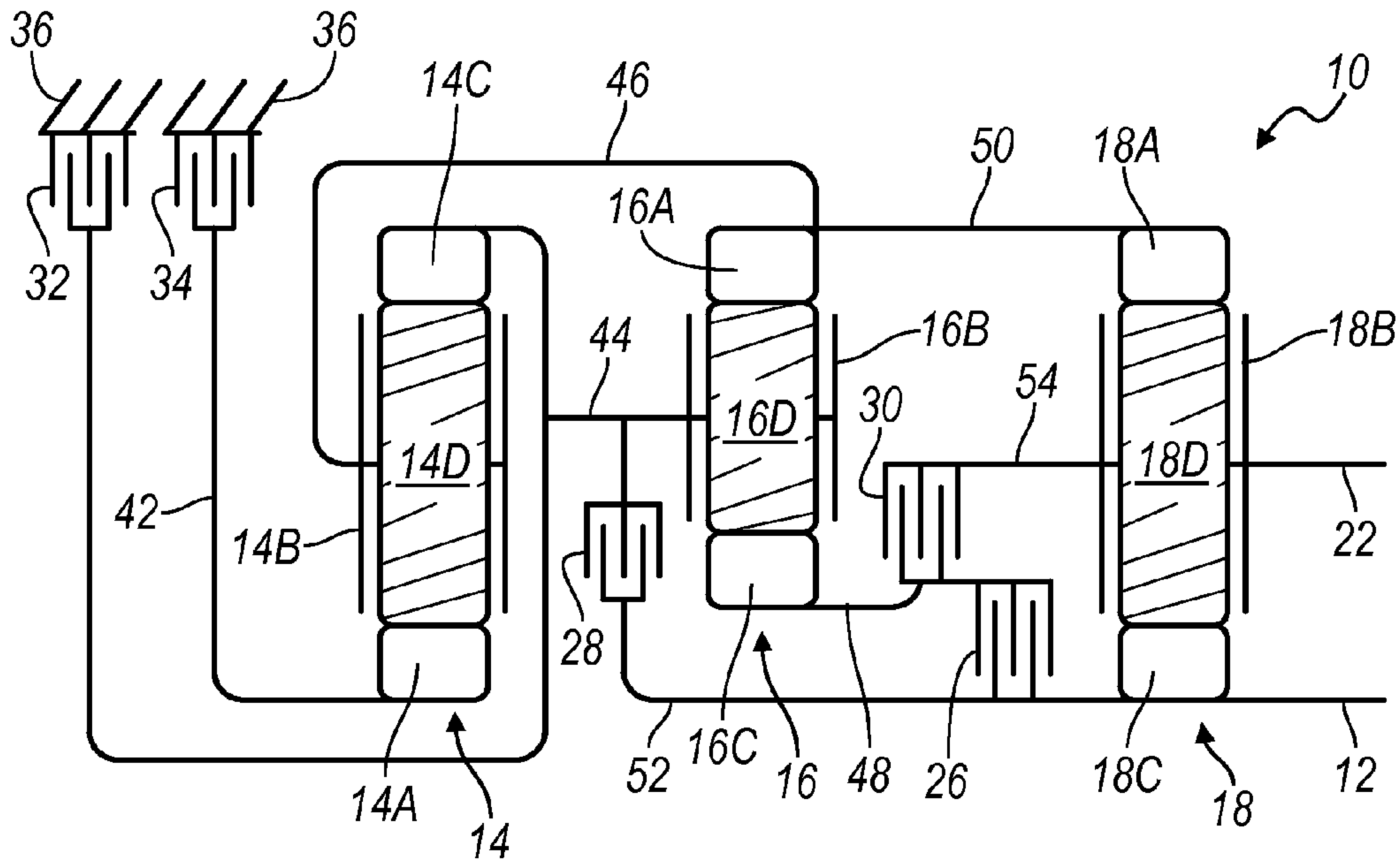
9 Claims, 7 Drawing Sheets





10
12
18C
26
16C
30
18B
14C,16B
22
28
32
14B,16A
18A
18
36
34
14A
14,16

FIG. 1



36
36
14C
46
10
50
18A
16A
32
34
44
16B
18B
30
54
16D
14D
18D
42
14B
28
22
14A
14
52
16C
16
48
26
18C
18
12

FIG. 2

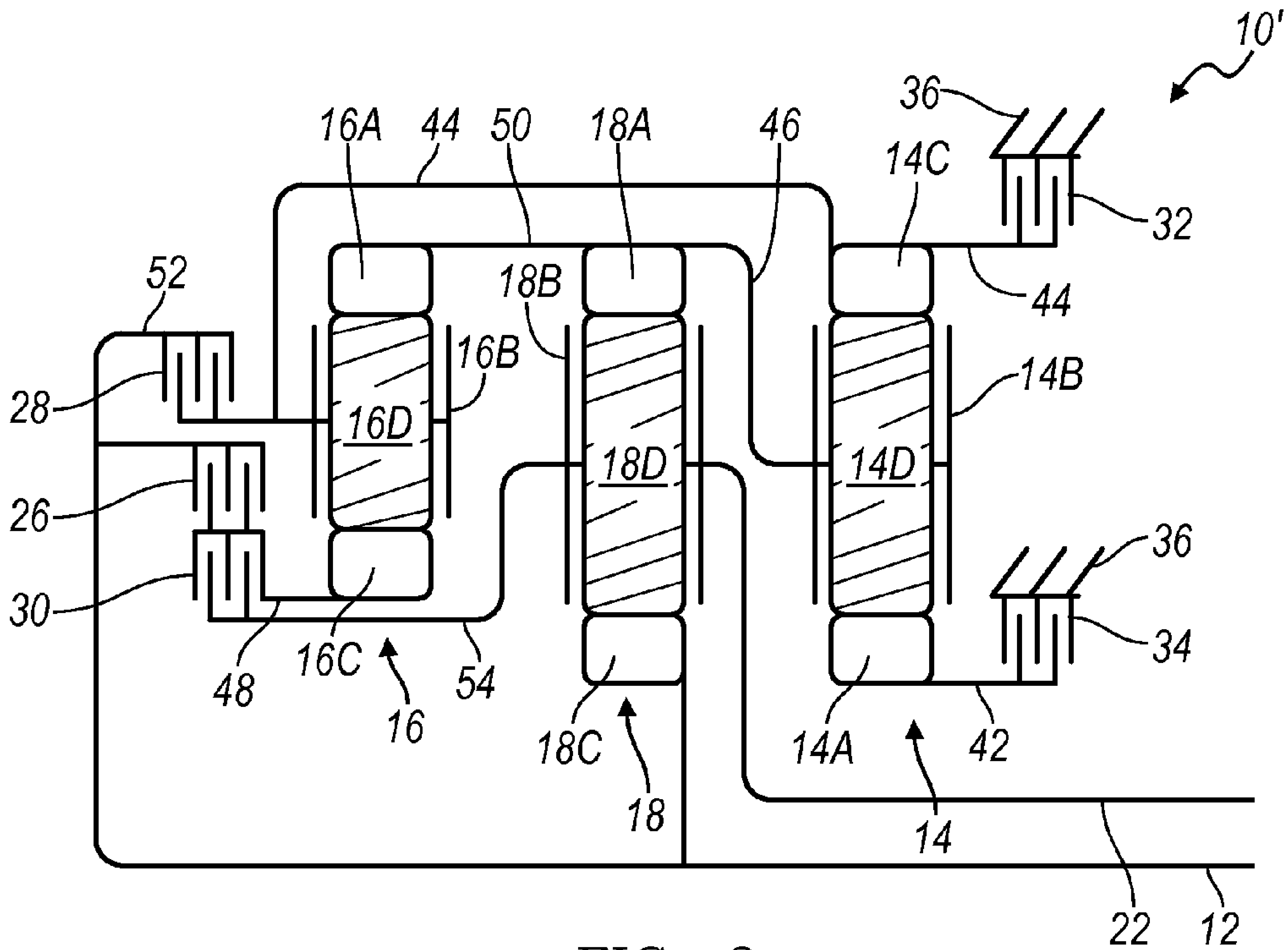


FIG. 3

GEAR STATE	GEAR RATIO	RATIO STEP	TORQUE TRANSMITTING ELEMENTS				
			32	26	30	34	28
REV	-5.667		X	G			
N		-1.13	O				
1ST	5.000		X		G		
2ND	3.400	1.47	X			X	
3RD	2.224	1.53			X	X	
4TH	1.563	1.42		X		X	
5TH	1.262	1.24				X	X
6TH	1.000	1.26			X		X

X = ON - ENGAGED CARRYING TORQUE
O = ON - ENGAGED NOT CARRYING TORQUE
G = ON - GARAGE SHIFT ELEMENT ON AND CARRYING TORQUE

FIG. 4

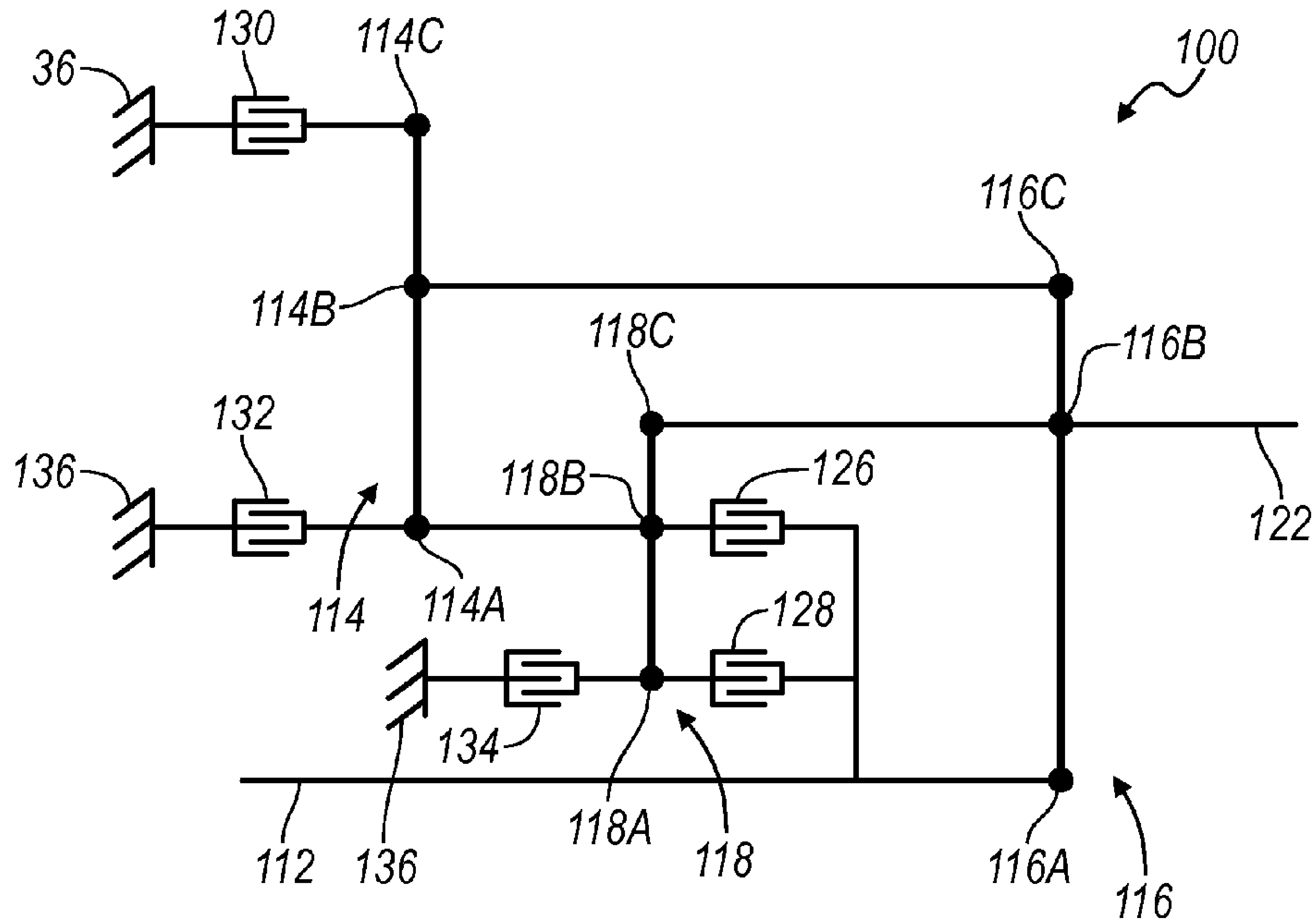

36
130
114C
100
116C
114B
118C
116B
132
136
126
118B
122
114
114A
128
134
112
136
118A
118
116A
116

FIG. 5

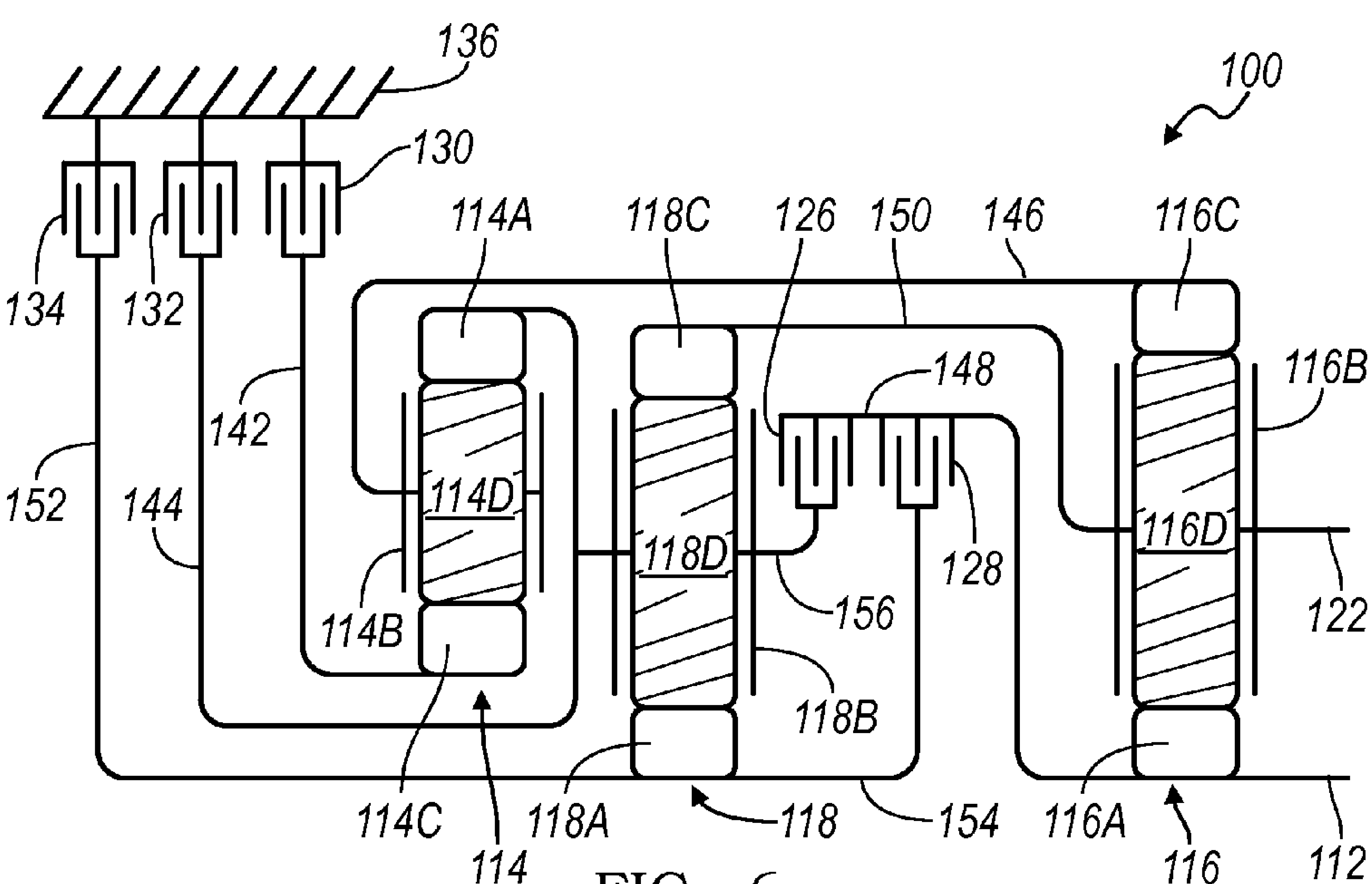

136
100
130
134
132
114A
118C
126
150
146
116C
148
116B
142
152
144
114D
118D
116D
156
128
122
114B
118B
114C
118A
118
154
116A
114
116
112

FIG. 6

GEAR STATE	GEAR RATIO	RATIO STEP	TORQUE TRANSMITTING ELEMENTS				
			132	130	134	126	128
REV	-3.200		X				X
N		-0.84	O				
1ST	3.800		X	X			
2ND	2.333	1.63		X	X		
3RD	1.600	1.46		X			X
4TH	1.299	1.23		X		X	
5TH	1.000	1.30				X	X
6TH	0.762	1.31			X	X	

X = ON - ENGAGED CARRYING TORQUE
O = ON - ENGAGED NOT CARRYING TORQUE

FIG. 7

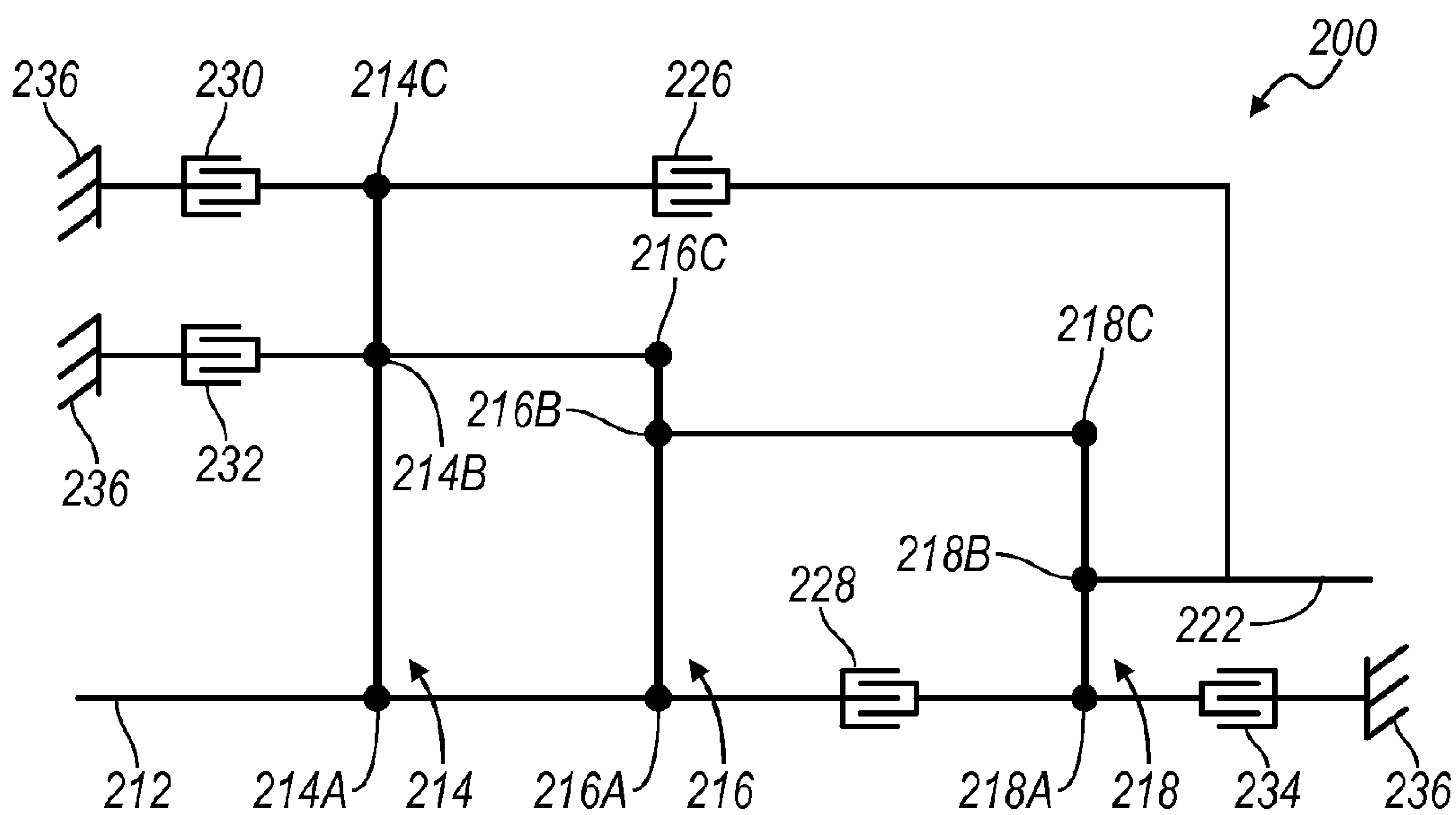


FIG. 8

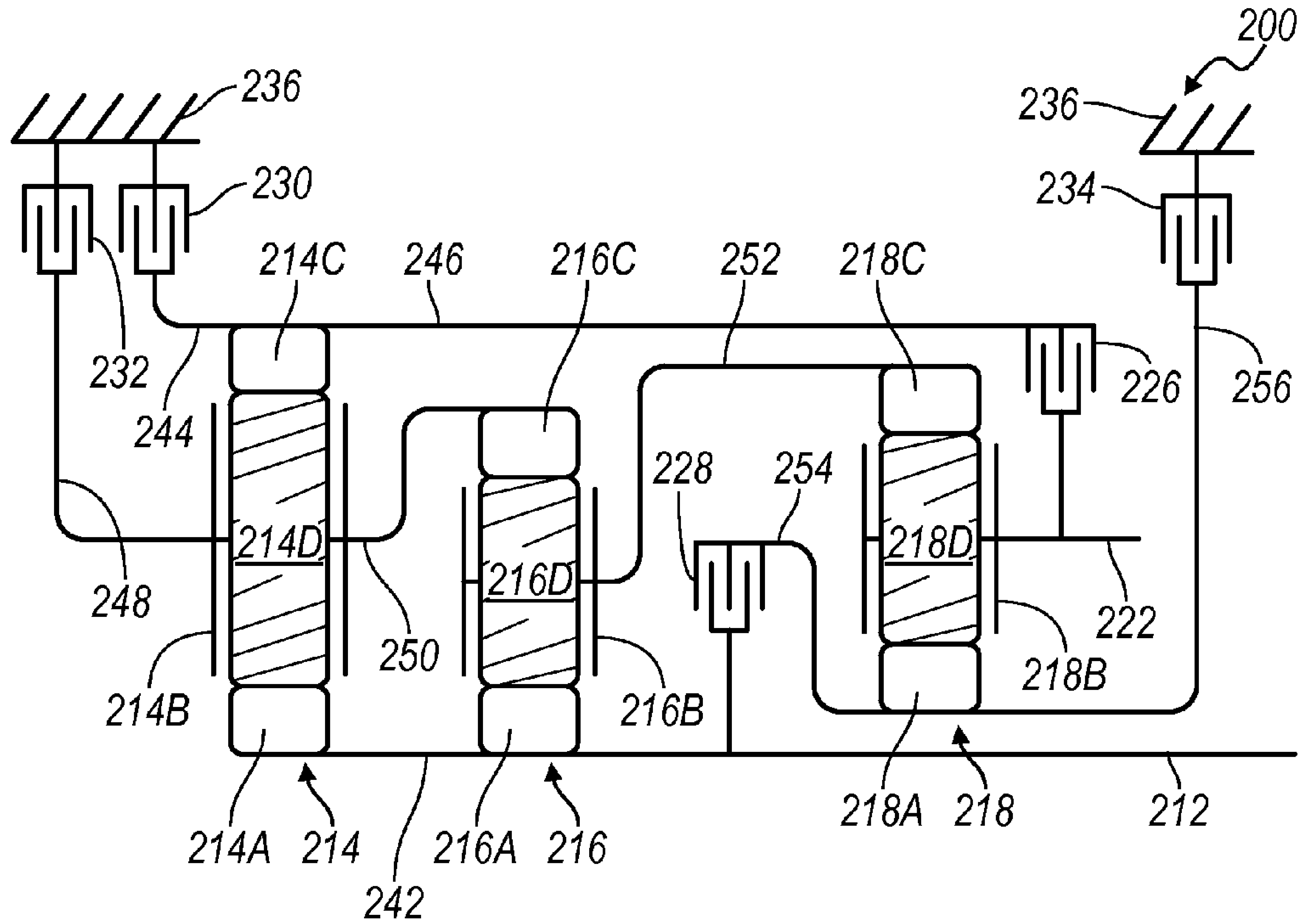


FIG. 9

GEAR STATE	GEAR RATIO	RATIO STEP	TORQUE TRANSMITTING ELEMENTS				
			230	232	234	226	228
REV	-1.800			X		X	
N		-0.40		O			
1ST	4.497			X	X		
2ND	2.737	1.64	X		X		
3RD	2.033	1.35			X	X	
4TH	1.667	1.22		X			X
5TH	1.346	1.24	X				X
6TH	1.000	1.35				X	X

X = ON - ENGAGED CARRYING TORQUE
O = ON - ENGAGED NOT CARRYING TORQUE

FIG. 10

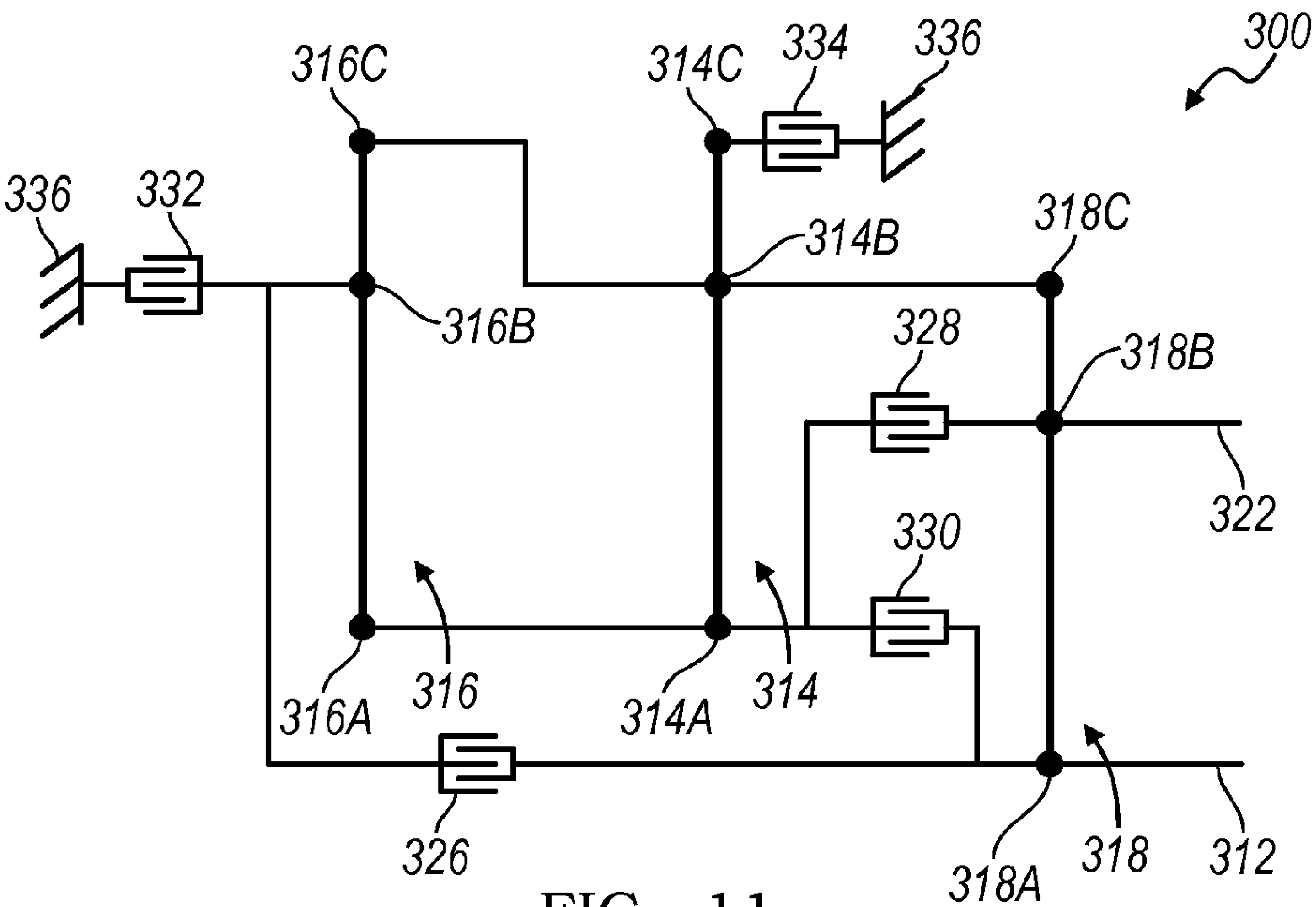

300
316C
314C
334
336
336
332
314B
318C
316B
328
318B
322
330
316
314
316A
314A
326
318
312
318A

FIG. 11

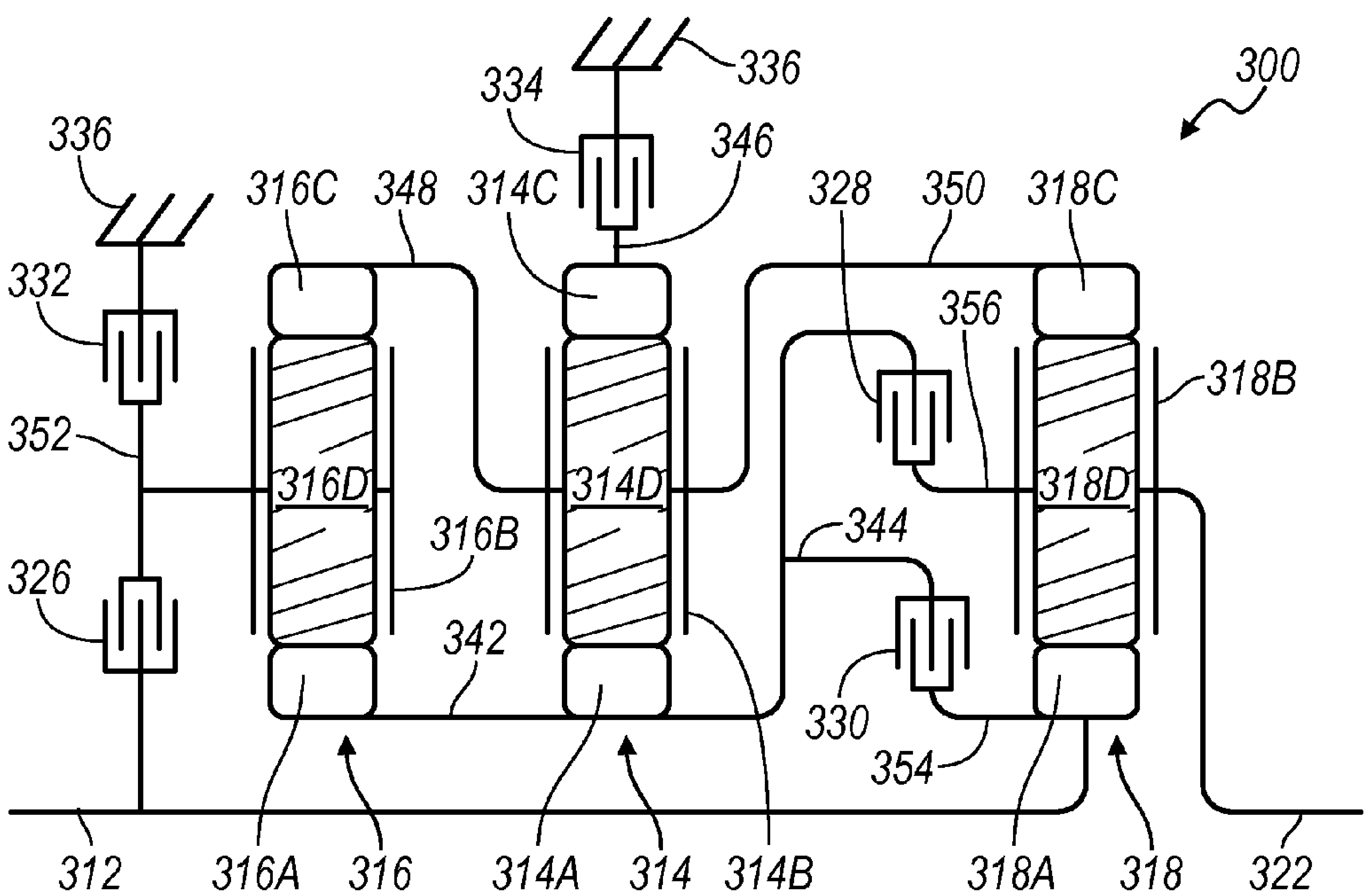

336
300
334
346
336
316C
348
314C
328
350
318C
332
356
318B
352
316D
314D
318D
344
316B
326
342
330
354
312
316A
316
314A
314
314B
318A
318
322

FIG. 12

GEAR STATE	GEAR RATIO	RATIO STEP	TORQUE TRANSMITTING ELEMENTS				
			334	332	330	328	326
REV	-6.794			X	X		
N		-1.35					
1ST	5.015			X		X	
2ND	3.500	1.43	X	X			
3RD	2.520	1.39	X			X	
4TH	1.767	1.43	X		X		
5TH	1.358	1.30	X				X
6TH	1.000	1.36			X	X	

X = ON - ENGAGED CARRYING TORQUE
O = ON - ENGAGED NOT CARRYING TORQUE

FIG. 13

MULTI-SPEED TRANSMISSION HAVING THREE PLANETARY GEAR SETS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority to U.S. Provisional Application No. 61/231,505, filed on Aug. 5, 2009, which is hereby incorporated in its entirety herein by reference.

FIELD

The invention relates generally to a multiple speed transmission having a plurality of planetary gear sets and a plurality of torque transmitting devices and more particularly to a transmission having six or more speeds, three planetary gear sets and a plurality of torque transmitting devices.

BACKGROUND

The statements in this section merely provide background information related to the present disclosure and may or may not constitute prior art.

A typical multiple speed transmission uses a combination of friction clutches, planetary gear arrangements and fixed interconnections to achieve a plurality of gear ratios. The number and physical arrangement of the planetary gear sets, generally, are dictated by packaging, cost and desired speed ratios.

While current transmissions achieve their intended purpose, the need for new and improved transmission configurations which exhibit improved performance, especially from the standpoints of efficiency, responsiveness and smoothness and improved packaging, primarily reduced size and weight, is essentially constant. Accordingly, there is a need for an improved, cost-effective, compact multiple speed transmission.

SUMMARY

A transmission is provided having an input member, an output member, three planetary gear sets, a plurality of coupling members and a plurality of torque transmitting devices. Each of the planetary gear sets includes first, second and third members. The torque transmitting devices are for example clutches and brakes.

In one embodiment, a transmission includes an input member, an output member, first, second and third planetary gear sets each having first, second and third members, a first interconnecting member continuously interconnecting the second member of the first planetary gear set with the third member of the second planetary gear set, a second interconnecting member continuously interconnecting the first member of the first planetary gear set with the second member of the third planetary gear set, and a third interconnecting member continuously interconnecting the third member of the third planetary gear set with the second member of the second planetary gear set. A first torque transmitting mechanism is selectively engageable to interconnect the first member of the first planetary gear set and the second member of the third planetary gear set with the first member of the second planetary gear set and the input member, a second torque transmitting mechanism is selectively engageable to interconnect the first member of the third planetary gear set with the first member of the second planetary gear set and the input member, a third torque transmitting mechanism is selectively engageable to interconnect the third member of the first planetary gear set with a stationary member, a fourth torque transmitting mechanism is selectively engageable to interconnect the first member of the first planetary gear set and the second member of the third planetary gear set with the stationary member, and a fifth torque transmitting mechanism selectively engageable to interconnect the first member of the third planetary gear set with the stationary member. The torque transmitting mechanisms are selectively engageable in combinations of at least two to establish at least six forward speed ratios and at least one reverse speed ratio between the input member and the output member.

In another embodiment, a transmission includes an input member, an output member, first, second and third planetary gear sets each having first, second and third members, a first interconnecting member continuously interconnecting the first member of the first planetary gear set with the first member of the second planetary gear set, a second interconnecting member continuously interconnecting the second member of the first planetary gear set with the third member of the second planetary gear set, and a third interconnecting member continuously interconnecting the second member of the second planetary gear set with the third member of the third planetary gear set. A first torque transmitting mechanism is selectively engageable to interconnect the third member of the first planetary gear set with the second member of the third planetary gear set and the output member, a second torque transmitting mechanism is selectively engageable to interconnect the first member of the first planetary gear set, the first member of the second planetary gear set, and the input member with the first member of the third planetary gear set, a third torque transmitting mechanism is selectively engageable to interconnect the third member of the first planetary gear set with a stationary member, a fourth torque transmitting mechanism is selectively engageable to interconnect the second member of the first planetary gear set and the third member of the second planetary gear set with the stationary member, and a fifth torque transmitting mechanism is selectively engageable to interconnect the first member of the third planetary gear set with the stationary member. The torque transmitting mechanisms are selectively engageable in combinations of at least two to establish at least six forward speed ratios and at least one reverse speed ratio between the input member and the output member.

In another embodiment, a transmission includes an input member, an output member, first, second and third planetary gear sets each having first, second and third members, a first interconnecting member continuously interconnecting the first member of the first planetary gear set with the first member of the second planetary gear set, and a second interconnecting member continuously interconnecting the second member of the first planetary gear set with the third member of the second planetary gear set and the third member of the third planetary gear set. A first torque transmitting mechanism is selectively engageable to interconnect the second member of the second planetary gear set with the first member of the third planetary gear set and the output member, a second torque transmitting mechanism is selectively engageable to interconnect the first member of the first planetary gear set and the first member of the second planetary gear set with the output member and the second member of the third planetary gear set, a third torque transmitting mechanism is selectively engageable to interconnect the first member of the first planetary gear set and the first member of the second planetary gear set with the first member of the third planetary gear set and the input member, a fourth torque transmitting mechanism is selectively engageable to interconnect the second member of the second planetary gear set with a stationary member, and a fifth torque transmitting mechanism selectively engageable to interconnect the third member of the first planetary gear set with the stationary member. The torque transmitting mechanisms are selectively engageable in combinations of at least two to establish at least six forward speed ratios and at least one reverse speed ratio between the input member and the output member.

Further features, aspects and advantages of the present invention will become apparent by reference to the following description and appended drawings wherein like reference numbers refer to the same component, element or feature.

DRAWINGS

The drawings described herein are for illustration purposes only and are not intended to limit the scope of the present disclosure in any way.

FIG. **1** is a lever diagram of an embodiment of a six speed transmission according to the present invention;

FIG. **2** is a diagrammatic illustration of an embodiment of a six speed transmission according to the present invention;

FIG. **3** is a diagrammatic illustration of another embodiment of a six speed transmission according to the present invention;

FIG. **4** is a truth table presenting the state of engagement of the various torque transmitting elements in each of the available forward and reverse speeds or gear ratios of the transmissions illustrated in FIGS. **1-3**;

FIG. **5** is a lever diagram of an embodiment of a six speed transmission according to the present invention;

FIG. **6** is a diagrammatic illustration of an embodiment of a six speed transmission according to the present invention;

FIG. **7** is a truth table presenting the state of engagement of the various torque transmitting elements in each of the available forward and reverse speeds or gear ratios of the transmission illustrated in FIGS. **5** and **6**;

FIG. **8** is a lever diagram of an embodiment of a six speed transmission according to the present invention;

FIG. **9** is a diagrammatic illustration of an embodiment of a six speed transmission according to the present invention;

FIG. **10** is a truth table presenting the state of engagement of the various torque transmitting elements in each of the available forward and reverse speeds or gear ratios of the transmission illustrated in FIGS. **8** and **9**;

FIG. **11** is a lever diagram of an embodiment of a six speed transmission according to the present invention;

FIG. **12** is a diagrammatic illustration of an embodiment of a six speed transmission according to the present invention; and

FIG. **13** is a truth table presenting the state of engagement of the various torque transmitting elements in each of the available forward and reverse speeds or gear ratios of the transmission illustrated in FIGS. **11** and **12**.

DETAILED DESCRIPTION

The following description is merely exemplary in nature and is not intended to limit the present disclosure, application, or uses.

At the outset, it should be appreciated that the embodiments of the six speed automatic transmission of the present invention have an arrangement of permanent mechanical connections between the elements of the three planetary gear sets. A second component or element of a first planetary gear set is permanently coupled to a first component or element of a second planetary gear set. A third component or element of the first planetary gear set is permanently coupled to a second component or element of a third planetary gear set. A first component or element of the third planetary gear set is permanently coupled to a second component or element of the second planetary gear set.

Referring now to FIG. **1**, an embodiment of a six speed transmission **10** is illustrated in a lever diagram format. A lever diagram is a schematic representation of the components of a mechanical device such as an automatic transmission. Each individual lever represents a planetary gear set wherein the three basic mechanical components of the planetary gear are each represented by a node. Therefore, a single lever contains three nodes: one for the sun gear, one for the planet gear carrier, and one for the ring gear. In some cases, two levers may be combined into a single lever having more than three nodes (typically four nodes). For example, if two nodes on two different levers are interconnected through a fixed connection they may be represented as a single node on a single lever. The relative length between the nodes of each lever can be used to represent the ring-to-sun ratio of each respective gear set. These lever ratios, in turn, are used to vary the gear ratios of the transmission in order to achieve an appropriate ratios and ratio progression. Mechanical couplings or interconnections between the nodes of the various planetary gear sets are illustrated by thin, horizontal lines and torque transmitting devices such as clutches and brakes are presented as interleaved fingers. Further explanation of the format, purpose and use of lever diagrams can be found in SAE Paper 810102, "The Lever Analogy: A New Tool in Transmission Analysis" by Benford and Leising which is hereby fully incorporated by reference.

The transmission **10** includes an input shaft or member **12**, a first planetary gear set **14**, a second planetary gear set **16**, a third planetary gear set **18** and an output shaft or member **22**. In the lever diagram of FIG. **1**, the levers for the first planetary gear set **14** and the second planetary gear set **16** have been combined into a single four node lever **14**,**16** having: a first node **14**A, a second node **14**B, **16**A, a third node **14**C, **16**B and a fourth node **16**C. The third planetary gear set **18** has three nodes: a first node **18**A, a second node **18**B and a third node **18**C.

The input member **12** is continuously coupled to the third node **18**C of the third planetary gear set **18**. The output member **22** is coupled to the second node **18**B of the third planetary gear set **18**. The third node **14**C of the first planetary gear set **14** is coupled to the second node **16**B of the second planetary gear set **16**. The first node **16**A of the second planetary gear set **16** is coupled to the second node **14**B of the first planetary gear set **14** and to the first node **18**A of the third planetary gear set **18**.

A first clutch **26** selectively connects the input member **12** and the third node **18**C of the third planetary gear set **18** with the third node **16**C of the second planetary gear set **16**. A second clutch **28** selectively connects the input member **12** and the third node **18**C of the third planetary gear set **18** with the third node **14**C of the first planetary gear set **14** and the second node **16**B of the second planetary gear set **16**. A third clutch **30** selectively connects the third node **16**C of the second planetary gear set **16** with the second node **18**B of the third planetary gear set **18** and the output member or shaft **22**. A first brake **32** selectively connects the third node **14**C of the first planetary gear set **14** and the second node **16**B of the second planetary gear set **16** with a stationary member or transmission housing **36**. A second brake **34** selectively connects the first node **14**A of the first planetary gear set **14** with a stationary member or transmission housing **36**.

Referring now to FIG. **2**, a stick diagram presents a schematic layout of the embodiment of the six speed transmission

10 according to the present invention. In FIG. **2**, the numbering from the lever diagram of FIG. **1** is carried over. The clutches and couplings are correspondingly presented whereas the nodes of the planetary gear sets now appear as components of planetary gear sets such as sun gears, ring gears, planet gears and planet gear carriers.

For example, the planetary gear set **14** includes a sun gear member **14**A, a ring gear member **14**C and a planet gear carrier member **14**B that rotatably supports a set of planet gears **14**D (only one of which is shown). The sun gear member **14**A is connected for common rotation with a first shaft or interconnecting member **42**. The ring gear member **14**C is connected for common rotation with a second shaft or interconnecting member **44**. The planet carrier member **14**B is connected for common rotation with a third shaft or interconnecting member **46**. The planet gears **14**D are each configured to intermesh with both the sun gear member **14**A and the ring gear member **14**C.

The planetary gear set **16** includes a sun gear member **16**C, a ring gear member **16**A and a planet gear carrier member **16**B that rotatably supports a set of planet gears **16**D (only one of which is shown). The sun gear member **16**C is connected for common rotation with a fourth shaft or interconnecting member **48**. The ring gear member **16**A is connected for common rotation with the third shaft or interconnecting member **46** and a fifth shaft or interconnecting member **50**. The planet carrier member **16**B is connected for common rotation with the second shaft or interconnecting member **44**. The planet gears **16**D are each configured to intermesh with both the sun gear member **16**C and the ring gear member **16**A.

The planetary gear set **18** includes a sun gear member **18**C, a ring gear member **18**A and a planet gear carrier member **18**B that rotatably supports a set of planet gears **18**D (only one of which is shown). The sun gear member **18**C is connected for common rotation with sixth shaft or interconnecting member **52** and the input member **12**. The ring gear member **18**A is connected for common rotation with the fifth shaft or interconnecting member **50**. The planet carrier member **18**B is connected for common rotation with a seventh shaft or interconnecting member **54** and with the output member or shaft **22**. The planet gears **18**D are each configured to intermesh with both the sun gear member **18**C and the ring gear member **18**A.

The input shaft or member **12** is continuously connected to an engine (not shown) or to a turbine of a torque converter (not shown). The output shaft or member **22** is continuously connected with the final drive unit or transfer case (not shown).

The torque-transmitting mechanisms or clutches **26**, **28**, **30** and brakes **32** and **34** allow for selective interconnection of the shafts or interconnecting members, members of the planetary gear sets and the housing. For example, the first clutch **26** is selectively engageable to connect the sixth shaft or interconnecting member **52** and the input member **12** with the fourth shaft or interconnecting member **48**. The second clutch **28** is selectively engageable to connect the sixth shaft or interconnecting member **52** and the input member **12** with the second shaft or interconnecting member **44**. The third clutch **30** is selectively engageable to connect the fourth shaft or interconnecting member **48** with the seventh shaft or interconnecting member **54** and the output member **22**. The first brake **32** is selectively engageable to connect the second shaft or interconnecting member **44** with the stationary element or the transmission housing **36** in order to restrict the member **44** from rotating relative to the transmission housing **36**. The second brake **34** is selectively engageable to connect the first shaft or interconnecting member **42** with the stationary element or the transmission housing **36** in order to restrict the member **42** from rotating relative to the transmission housing **36**.

Referring to FIG. **3**, a stick diagram presents a schematic layout of an embodiment of the six speed transmission **10'** according to the present invention. In FIG. **3**, the numbering from the lever diagram of FIG. **1** and the stick diagram of FIG. **2** is carried over. The clutches and couplings are correspondingly presented whereas the nodes of the planetary gear sets now appear as components of planetary gear sets such as sun gears, ring gears, planet gears and planet gear carriers. The transmission **10'** is similar to the transmission **10** shown in FIG. **2**, however, the transmission **10'** has an arrangement of planetary gear sets **14**, **16**, and **18** that is different from the arrangement of planetary gear sets **14**, **16**, and **18** shown in FIG. **2**. The planetary gear sets **14**, **16**, and **18** of the transmission **10'** are ordered, from left to right, as follows: **16-18-14**. In contrast, the planetary gear sets **14**, **16**, and **18** of the transmission **10** shown in FIG. **2** are ordered, from left to right, as follows: **14-16-18**.

Referring now to FIGS. **2-4**, the operation of the embodiment of the six speed transmission **10** and **10'** will be described. It will be appreciated that transmissions **10** and **10'** are capable of transmitting torque from the input shaft or member **12** to the output shaft or member **22** in at least six forward speed or torque ratios and at least one reverse speed or torque ratio. Each forward and reverse speed or torque ratio is attained by engagement of one or more of the torque-transmitting mechanisms (i.e. first clutch **26**, second clutch **28**, third clutch **30**, first brake **32** and second brake **34**), as will be explained below. FIG. **4** is a truth table presenting the various combinations of torque-transmitting mechanisms that are activated or engaged to achieve the various gear states. An "X" in the box means that the particular clutch or brake is engaged to achieve the desired gear state. An "O" represents that the particular torque transmitting device (i.e. a brake or clutch) is on or active, but not carrying torque. A "G" represents that a garage shift element has to switch on and carrying torque when the transmission mode selector or shifter (Park, Reverse, Neutral, Drive or Low gear selector) is moved from reverse to drive and switch off when shifting back to reverse. Actual numerical gear ratios of the various gear states are also presented although it should be appreciated that these numerical values are exemplary only and that they may be adjusted over significant ranges to accommodate various applications and operational criteria of the transmissions **10** and **10'**. An example of the gear ratios that may be obtained using the embodiments of the present invention are also shown in FIG. **4**. Of course, other gear ratios are achievable depending on the gear diameter, gear teeth count and gear configuration selected.

To establish a reverse gear, the first clutch **26** and the first brake **32** are engaged or activated. The first clutch **26** connects the sixth shaft or interconnecting member **52** and the input member **12** with the fourth shaft or interconnecting member **48**. The first brake **32** connects the second shaft or interconnecting member **44** with the stationary element or the transmission housing **36** in order to restrict the member **44** from rotating relative to the transmission housing **36**. Likewise, the six forward ratios are achieved through different combinations of clutch and brake engagement, as shown in FIG. **4**.

It will be appreciated that the foregoing explanation of operation and gear states of the six speed transmissions **10** and **10'** assumes, first of all, that all the clutches not specifically referenced in a given gear state are inactive or disengaged and, second of all, that during gear shifts, i.e., changes of gear state, between at least adjacent gear states, a clutch engaged or activated in both gear states will remain engaged or activated.

Referring now to FIG. **5**, another embodiment of a six speed transmission **100** is illustrated in a lever diagram format. The transmission **100** includes an input shaft or member **112**, a first planetary gear set **114**, a second planetary gear set **116**, a third planetary gear set **118** and an output shaft or member **122**. The first planetary gear set **114** has three nodes: a first node **114**A, a second node **114**B, and a third node **114**C. The second planetary gear set **116** has three nodes: a first node **116**A, a second node **116**B, and a third node **116**C. The third planetary gear set **118** has three nodes: a first node **118**A, a second node **118**B and a third node **118**C.

The input member **112** is continuously coupled to the first node **116**A of the second planetary gear set **116**. The output member **122** is coupled to the third node **118**C of the third planetary gear set **118** and to the second node **1168** of the second planetary gear set **116**. The second node **1148** of the first planetary gear set **114** is coupled to the third node **116**C of the second planetary gear set **116**. The first node **114**A of the first planetary gear set **114** is coupled to the second node **1188** of the third planetary gear set **118**. The third node **118**C of the third planetary gear set **118** is coupled to the second node **116**B of the second planetary gear set **116** and the output member **122**.

A first clutch **126** selectively connects the first node **114**A of the first planetary gear set **114** and the second node **118**B of the third planetary gear set **118** with the first node **116**A of the second planetary gear set **116** and the input member **112**. A second clutch **128** selectively connects the first node **118**A of the third planetary gear set **118** with the input member **112** and the first node **116**A of the second planetary gear set **116**. A first brake **130** selectively connects the third node **114**C of the first planetary gear set **114** with a stationary member or transmission housing **136**. A second brake **132** selectively connects the second node **1188** of the third planetary gear set **118** and the first node **114**A of the first planetary gear set **114** with a stationary member or transmission housing **136**. A third brake **134** selectively connects the first node **118**A of the third planetary gear set **118** with a stationary member or transmission housing **136**.

Referring now to FIG. **6**, a stick diagram presents a schematic layout of the embodiment of the six speed transmission **100** according to the present invention. In FIG. **6**, the numbering from the lever diagram of FIG. **5** is carried over. The clutches and couplings are correspondingly presented whereas the nodes of the planetary gear sets now appear as components of planetary gear sets such as sun gears, ring gears, planet gears and planet gear carriers.

For example, the planetary gear set **114** includes a sun gear member **114**C, a ring gear member **114**A and a planet gear carrier member **1148** that rotatably supports a set of planet gears **114**D (only one of which is shown). The sun gear member **114**C is connected for common rotation with a first shaft or interconnecting member **142**. The ring gear member **114**A is connected for common rotation with a second shaft or interconnecting member **144**. The planet carrier member **114**B is connected for common rotation with a third shaft or interconnecting member **146**. The planet gears **114**D are each configured to intermesh with both the sun gear member **114**C and the ring gear member **114**A.

The planetary gear set **116** includes a sun gear member **116**A, a ring gear member **116**C and a planet gear carrier member **116**B that rotatably supports a set of planet gears **116**D (only one of which is shown). The sun gear member **116**A is connected for common rotation with a fourth shaft or interconnecting member **148** and the input member **112**. The ring gear member **116**C is connected for common rotation with the third shaft or interconnecting member **146**. The planet carrier member **116**B is connected for common rotation with a fifth shaft or interconnecting member **150** and with the output member **122**. The planet gears **116**D are each configured to intermesh with both the sun gear member **116**A and the ring gear member **116**C.

The planetary gear set **118** includes a sun gear member **118**A, a ring gear member **118**C and a planet gear carrier member **118**B that rotatably supports a set of planet gears **118**D (only one of which is shown). The sun gear member **118**A is connected for common rotation with a sixth shaft or interconnecting member **152** and a seventh shaft or interconnecting member **154**. The ring gear member **118**C is connected for common rotation with the fifth interconnecting member **150**. The planet carrier member **118**B is connected for common rotation with an eighth shaft or interconnecting member **156** and with the second interconnecting member **144**. The planet gears **118**D are each configured to intermesh with both the sun gear member **118**A and the ring gear member **118**C.

The input shaft or member **112** is continuously connected to an engine (not shown) or to a turbine of a torque converter (not shown). The output shaft or member **122** is continuously connected with the final drive unit or transfer case (not shown).

The torque-transmitting mechanisms or clutches **126** and **128** and brakes **130**, **132** and **134** allow for selective interconnection of the shafts or interconnecting members, members of the planetary gear sets and the housing. For example, the first clutch **126** is selectively engageable to connect the eighth shaft or interconnecting member **156** and the second shaft or interconnecting member **144** with the fourth shaft or interconnecting member **148** and the input member **112**. The second clutch **128** is selectively engageable to connect the sixth shaft or interconnecting member **152** and the seventh shaft or interconnecting member **154** with the fourth shaft or interconnecting member **148** and the input shaft or member **112**. The first brake **130** is selectively engageable to connect the first shaft or interconnecting member **142** with the stationary element or the transmission housing **136** in order to restrict the member **142** from rotating relative to the transmission housing **136**. The second brake **132** is selectively engageable to connect the second shaft or interconnecting member **144** and the eighth shaft or interconnecting member **156** with the stationary element or the transmission housing **136** in order to restrict the members **144** and **156** from rotating relative to the transmission housing **136**. The third brake **134** is selectively engageable to connect the sixth shaft or interconnecting member **152** and the seventh shaft or interconnecting member **154** with the stationary element or the transmission housing **136** in order to restrict the members **152** and **154** from rotating relative to the transmission housing **136**.

Referring now to FIG. **6** and FIG. **7**, the operation of the embodiment of the six speed transmission **100** will be described. It will be appreciated that transmission **100** is capable of transmitting torque from the input shaft or member **112** to the output shaft or member **122** in at least six forward speed or torque ratios and at least one reverse speed or torque ratio. Each forward and reverse speed or torque ratio is attained by engagement of one or more of the torque-transmitting mechanisms (i.e. first clutch **126**, second clutch **128**, first brake **130**, second brake **132**, and third brake **134**), as will be explained below. FIG. **7** is a truth table presenting the various combinations of torque-transmitting mechanisms that are activated or engaged to achieve the various gear states. An "X" in the box means that the particular clutch or brake is engaged to achieve the desired gear state. An "O" represents that the particular torque transmitting device (i.e. a brake or clutch) is on or active, but not carrying torque. Actual numerical gear ratios of the various gear states are also presented although it should be appreciated that these numerical values are exemplary only and that they may be adjusted over significant ranges to accommodate various applications and operational criteria of the transmission **100**. An example of the gear ratios that may be obtained using the embodiments of the present invention are also shown in FIG. **7**. Of course, other gear ratios are achievable depending on the gear diameter, gear teeth count and gear configuration selected.

To establish a reverse gear, the second clutch **128** and the second brake **132** are engaged or activated. The second clutch **128** connects the sixth shaft or interconnecting member **152** and the seventh shaft or interconnecting member **154** with the fourth shaft or interconnecting member **148** and the input shaft or member **112**. The second brake **132** connects the second shaft or interconnecting member **144** and the eighth shaft or interconnecting member **156** with the stationary element or the transmission housing **136** in order to restrict the members **144** and **156** from rotating relative to the transmission housing **136**. Likewise, the six forward ratios are achieved through different combinations of clutch and brake engagement, as shown in FIG. **7**.

It will be appreciated that the foregoing explanation of operation and gear states of the six speed transmission **100** assumes, first of all, that all the clutches not specifically referenced in a given gear state are inactive or disengaged and, second of all, that during gear shifts, i.e., changes of gear state, between at least adjacent gear states, a clutch engaged or activated in both gear states will remain engaged or activated.

Referring now to FIG. **8**, another embodiment of a six speed transmission **200** is illustrated in a lever diagram format. The transmission **200** includes an input shaft or member **212**, a first planetary gear set **214**, a second planetary gear set **216**, a third planetary gear set **218** and an output shaft or member **222**. The first planetary gear set **214** has three nodes: a first node **214**A, a second node **214**B, and a third node **214**C. The second planetary gear set **216** has three nodes: a first node **216**A, a second node **216**B, and a third node **216**C. The third planetary gear set **218** has three nodes: a first node **218**A, a second node **218**B and a third node **218**C.

The input member **212** is continuously coupled to the first node **214**A of the first planetary gear set **214** and the first node **216**A of the second planetary gear set **216**. The output member **222** is coupled to the second node **218**B of the third planetary gear set **218**. The third node **216**C of the second planetary gear set **216** is coupled to the second node **214**B of the first planetary gear set **214**. The second node **216**B of the second planetary gear set **216** is coupled to the third node **218**C of the third planetary gear set **218**. The first node **214**A of the first planetary gear set **214** is coupled to the first node **216**A of the second planetary gear set **216**.

A first clutch **226** selectively connects the third node **214**C of the first planetary gear set **214** with the second node **2188** of the third planetary gear set **218** and the output member **222**. A second clutch **228** selectively connects the first node **214**A of the first planetary gear set **214** and the first node **216**A of the second planetary gear set **216** with the first node **218**A of the third planetary gear set **218**. A first brake **230** selectively connects the third node **214**C of the first planetary gear set **214** with a stationary member or transmission housing **236**. A second brake **232** selectively connects the second node **214**B of the first planetary gear set **214** and the third node **216**C of the second planetary gear set **216** with a stationary member or transmission housing **236**. A third brake **234** selectively connects the first node **218**A of the third planetary gear set **218** with a stationary member or transmission housing **236**.

Referring now to FIG. **9**, a stick diagram presents a schematic layout of the embodiment of the six speed transmission **200** according to the present invention. In FIG. **9**, the numbering from the lever diagram of FIG. **8** is carried over. The clutches and couplings are correspondingly presented whereas the nodes of the planetary gear sets now appear as components of planetary gear sets such as sun gears, ring gears, planet gears and planet gear carriers.

For example, the planetary gear set **214** includes a sun gear member **214**A, a ring gear member **214**C and a planet gear carrier member **214**B that rotatably supports a set of planet gears **214**D (only one of which is shown). The sun gear member **214**A is connected for common rotation with a first shaft or interconnecting member **242**. The ring gear member **214**C is connected for common rotation with a second shaft or interconnecting member **244** and a third shaft or interconnecting member **246**. The planet carrier member **214**B is connected for common rotation with a fourth shaft or interconnecting member **248** and with a fifth shaft or interconnecting member **250**. The planet gears **214**D are each configured to intermesh with both the sun gear member **214**A and the ring gear member **214**C.

The planetary gear set **216** includes a sun gear member **216**A, a ring gear member **216**C and a planet gear carrier member **216**B that rotatably supports a set of planet gears **216**D (only one of which is shown). The sun gear member **216**A is connected for common rotation with the first shaft or interconnecting member **252** and the input shaft or member **212**. The ring gear member **216**C is connected for common rotation with the fifth shaft or interconnecting member **250**. The planet carrier member **216**B is connected for common rotation with a sixth shaft or interconnecting member **252**. The planet gears **216**D are each configured to intermesh with both the sun gear member **216**A and the ring gear member **216**C.

The planetary gear set **218** includes a sun gear member **218**A, a ring gear member **218**C and a planet gear carrier member **218**B that rotatably supports a set of planet gears **218**D (only one of which is shown). The sun gear member **218**A is connected for common rotation with a seventh shaft or interconnecting member **254** and an eighth shaft or interconnecting member **256**. The ring gear member **218**C is connected for common rotation with the sixth shaft or interconnecting member **252**. The planet carrier member **218**B is connected for common rotation with the output member **222**. The planet gears **218**D are each configured to intermesh with both the sun gear member **218**A and the ring gear member **218**C.

The input shaft or member **212** is continuously connected to an engine (not shown) or to a turbine of a torque converter (not shown). The output shaft or member **222** is continuously connected with the final drive unit or transfer case (not shown).

The torque-transmitting mechanisms or clutches **226** and **228** and brakes **230**, **232** and **234** allow for selective interconnection of the shafts or interconnecting members, members of the planetary gear sets and the housing. For example, the first clutch **226** is selectively engageable to connect the second shaft or interconnecting member **244** and the third shaft or interconnecting member **246** with the output member **222**. The second clutch **228** is selectively engageable to connect the seventh shaft or interconnecting member **254** and the eighth shaft or interconnecting member **256** with the input member **212** and the first shaft or interconnecting member **242**. The first brake **230** is selectively engageable to connect the second shaft or interconnecting member **244** and the third shaft or interconnecting member **246** with the stationary element or the transmission housing **236** in order to restrict the members **244** and **246** from rotating relative to the transmission housing **236**. The second brake **232** is selectively engageable to connect the fourth shaft or interconnecting member **248** and the fifth shaft or interconnecting member **250** with the stationary element or the transmission housing **236** in order to restrict the members **248** and **250** from rotating relative to the transmission housing **236**. The third brake **234** is selectively engageable to connect the seventh shaft or interconnecting member **254** and the eighth shaft or interconnecting member **256** with the stationary element or the transmission housing **236** in order to restrict the members **254** and **256** from rotating relative to the transmission housing **236**.

Referring now to FIG. **9** and FIG. **10**, the operation of the embodiment of the six speed transmission **200** will be described. It will be appreciated that transmission **200** is capable of transmitting torque from the input shaft or member **212** to the output shaft or member **222** in at least six forward speed or torque ratios and at least one reverse speed or torque ratio. Each forward and reverse speed or torque ratio is attained by engagement of one or more of the torque-transmitting mechanisms (i.e. first clutch **226**, second clutch **228**, first brake **230**, second brake **232** and third brake **234**), as will be explained below. FIG. **10** is a truth table presenting the various combinations of torque-transmitting mechanisms that are activated or engaged to achieve the various gear states. An "X" in the box means that the particular clutch or brake is engaged to achieve the desired gear state. An "O" represents that the particular torque transmitting device (i.e. a brake or clutch) is on or active, but not carrying torque. Actual numerical gear ratios of the various gear states are also presented although it should be appreciated that these numerical values are exemplary only and that they may be adjusted over significant ranges to accommodate various applications and operational criteria of the transmission **200**. An example of the gear ratios that may be obtained using the embodiments of the present invention are also shown in FIG. **10**. Of course, other gear ratios are achievable depending on the gear diameter, gear teeth count and gear configuration selected.

To establish a reverse gear, the first clutch **226** and the second brake **232** are engaged or activated. The first clutch **226** connects the second shaft or interconnecting member **244** and the third shaft or interconnecting member **246** with the output member **222**. The second brake **232** connects the fourth shaft or interconnecting member **248** and the fifth shaft or interconnecting member **250** with the stationary element or the transmission housing **236** in order to restrict the members **248** and **250** from rotating relative to the transmission housing **236**. Likewise, the six forward ratios are achieved through different combinations of clutch and brake engagement, as shown in FIG. **10**.

It will be appreciated that the foregoing explanation of operation and gear states of the six speed transmission **200** assumes, first of all, that all the clutches not specifically referenced in a given gear state are inactive or disengaged and, second of all, that during gear shifts, i.e., changes of gear state, between at least adjacent gear states, a clutch engaged or activated in both gear states will remain engaged or activated.

Referring now to FIG. **11**, another embodiment of a six speed transmission **300** is illustrated in a lever diagram format. The transmission **300** includes an input shaft or member **312**, a first planetary gear set **314**, a second planetary gear set **316**, a third planetary gear set **318** and an output shaft or member **322**. The first planetary gear set **314** has three nodes: a first node **314**A, a second node **314**B and a third node **314**C. The second planetary gear set **316** has three nodes: a first node **316**A, a second node **316**B and a third node **316**C. The third planetary gear set **318** has three nodes: a first node **318**A, a second node **318**B and a third node **318**C.

The input member **312** is continuously coupled to the first node **318**A of the third planetary gear set **318**. The output member **322** is coupled to the second node **318**B of the third planetary gear set **318**. The third node **316**C of the second planetary gear set **316** is coupled to the second node **3148** of the first planetary gear set **314** and to the third node **318**C of the third planetary gear set **318**. The first node **316**A of the second planetary gear set **316** is coupled to the first node **314**A of the first planetary gear set **314**.

A first clutch **326** selectively connects the input member **312** and the first node **318**A of the third planetary gear set **318** with the second node **316**B of the second planetary gear set **316**. A second clutch **328** selectively connects the output member **322** and the second node **318**B of the third planetary gear set **318** with the first node **314**A of the first planetary gear set **314** and the first node **316**A of the second planetary gear set **316**. A third clutch **330** selectively connects the input member **312** and the first node **318**A of the third planetary gear set **318** with the first node **314**A of the first planetary gear set **314** and the first node **316**A of the second planetary gear set **316**. A first brake **332** selectively connects the second node **3168** of the second planetary gear set **316** with a stationary member or transmission housing **336**. A second brake **334** selectively connects the third node **314**C of the first planetary gear set **314** with a stationary member or transmission housing **336**.

Referring now to FIG. **12**, a stick diagram presents a schematic layout of the embodiment of the six speed transmission **300** according to the present invention. In FIG. **12**, the numbering from the lever diagram of FIG. **11** is carried over. The clutches and couplings are correspondingly presented whereas the nodes of the planetary gear sets now appear as components of planetary gear sets such as sun gears, ring gears, planet gears and planet gear carriers.

For example, the planetary gear set **314** includes a sun gear member **314**A, a ring gear member **314**C and a planet gear carrier member **314**B that rotatably supports a set of planet gears **314**D (only one of which is shown). The sun gear member **314**A is connected for common rotation with a first shaft or interconnecting member **342** and a second shaft or interconnecting member **344**. The ring gear member **314**C is connected for common rotation with a third shaft or interconnecting member **346**. The planet carrier member **314**B is connected for common rotation with a fourth shaft or interconnecting member **348** and a fifth shaft or interconnecting member **350**. The planet gears **314**D are each configured to intermesh with both the sun gear member **314**A and the ring gear member **314**C.

The planetary gear set **316** includes a sun gear member **316**A, a ring gear member **316**C and a planet gear carrier member **316**B that rotatably supports a set of planet gears **316**D (only one of which is shown). The sun gear member **316**A is connected for common rotation with the first shaft or interconnecting member **342**. The ring gear member **316**C is connected for common rotation with the fourth shaft or interconnecting member **348**. The planet carrier member **316**B is connected for common rotation with a sixth shaft or interconnecting member **352**. The planet gears **316**D are each configured to intermesh with both the sun gear member **316**A and the ring gear member **316**C.

The planetary gear set **318** includes a sun gear member **318**A, a ring gear member **318**C and a planet gear carrier member **318**B that rotatably supports a set of planet gears **318**D (only one of which is shown). The sun gear member **318**A is connected for common rotation with a seventh shaft or interconnecting member **354** and the input member **312**. The ring gear member **318**C is connected for common rotation with the fifth shaft or interconnecting member **350**. The planet carrier member **3188** is connected for common rotation with an eighth shaft or interconnecting member **356** and with the output member or shaft **322**. The planet gears **318**D are each configured to intermesh with both the sun gear member **318**A and the ring gear member **318**C.

The input shaft or member **312** is continuously connected to an engine (not shown) or to a turbine of a torque converter (not shown). The output shaft or member **322** is continuously connected with the final drive unit or transfer case (not shown).

The torque-transmitting mechanisms or clutches **326**, **328**, **330** and brakes **332** and **334** allow for selective interconnection of the shafts or interconnecting members, members of the planetary gear sets and the housing. For example, the first clutch **326** is selectively engageable to connect the sixth shaft or interconnecting member **352** with the seventh shaft or interconnecting member **354** and the input member **12**. The second clutch **328** is selectively engageable to connect the first shaft or interconnecting member **342** and the second shaft or interconnecting member **344** with the eighth shaft or interconnecting member **356** and the output member **322**. The third clutch **330** is selectively engageable to connect the first shaft or interconnecting member **342** and the second shaft or interconnecting member **344** with the seventh shaft or interconnecting member **354** and the input member **312**. The first brake **332** is selectively engageable to connect the sixth shaft or interconnecting member **352** with the stationary element or the transmission housing **336** in order to restrict the member **352** from rotating relative to the transmission housing **336**. The second brake **334** is selectively engageable to connect the third shaft or interconnecting member **346** with the stationary element or the transmission housing **336** in order to restrict the member **346** from rotating relative to the transmission housing **336**.

Referring now to FIGS. **12** and **13**, the operation of the embodiment of the six speed transmission **300** will be described. It will be appreciated that transmission **300** is capable of transmitting torque from the input shaft or member **312** to the output shaft or member **322** in at least six forward speed or torque ratios and at least one reverse speed or torque ratio. Each forward and reverse speed or torque ratio is attained by engagement of one or more of the torque-transmitting mechanisms (i.e. first clutch **326**, second clutch **328**, third clutch **330**, first brake **332** and second brake **334**), as will be explained below. FIG. **13** is a truth table presenting the various combinations of torque-transmitting mechanisms that are activated or engaged to achieve the various gear states. An "X" in the box means that the particular clutch or brake is engaged to achieve the desired gear state. Actual numerical gear ratios of the various gear states are also presented although it should be appreciated that these numerical values are exemplary only and that they may be adjusted over significant ranges to accommodate various applications and operational criteria of the transmission **300**. An example of the gear ratios that may be obtained using the embodiments of the present invention are also shown in FIG. **13**. Of course, other gear ratios are achievable depending on the gear diameter, gear teeth count and gear configuration selected.

To establish a reverse gear, the third clutch **330** and the first brake **332** are engaged or activated. The third clutch **330** connects the first shaft or interconnecting member **342** and the second shaft or interconnecting member **344** with the seventh shaft or interconnecting member **354** and the input member **312**. The first brake **332** connects the sixth shaft or interconnecting member **352** with the stationary element or the transmission housing **336** in order to restrict the member **352** from rotating relative to the transmission housing **336**. Likewise, the six forward ratios are achieved through different combinations of clutch and brake engagement, as shown in FIG. **13**.

It will be appreciated that the foregoing explanation of operation and gear states of the six speed transmission **300** assumes, first of all, that all the clutches not specifically referenced in a given gear state are inactive or disengaged and, second of all, that during gear shifts, i.e., changes of gear state, between at least adjacent gear states, a clutch engaged or activated in both gear states will remain engaged or activated.

The description of the invention is merely exemplary in nature and variations that do not depart from the gist of the invention are intended to be within the scope of the invention. Such variations are not to be regarded as a departure from the spirit and scope of the invention.

The invention claimed is:

1. A transmission comprising:

an input member;

an output member;

first, second and third planetary gear sets each having first, second and third members, wherein the second members are carrier members, wherein the input and output members are each interconnected to at least one of the first, second, and third planetary gear sets, wherein the input member is continuously interconnected to the third member of the third planetary gear set;

a first interconnecting member continuously interconnecting the second member of the first planetary gear set with the first member of the second planetary gear set and the first member of the third planetary gear set;

a second interconnecting member continuously interconnecting the third member of the first planetary gear set with the second member of the second planetary gear set; and

five torque transmitting mechanisms each selectively engageable to interconnect at least one of the first, second and third members of the first, second and third planetary gear sets with at least one other of the first, second, third members and a stationary member, and

wherein the torque transmitting mechanisms are selectively engageable in combinations of at least two to establish at least six forward speed ratios and at least one reverse speed ratio between the input member and the output member.

2. The transmission of claim **1** wherein a first of the five torque transmitting mechanisms is selectively engageable to interconnect the third member of the third planetary gear set and the input member with the third member of the second planetary gear set.

3. The transmission of claim **2** wherein a second of the five torque transmitting mechanisms is selectively engageable to interconnect the third member of the third planetary gear set and the input member with the third member of the first planetary gear set and the second member of the second planetary gear set.

4. The transmission of claim **3** wherein a third of the five torque transmitting mechanisms is selectively engageable to interconnect the third member of the second planetary gear set with the second member of the third planetary gear set and the output member.

5. The transmission of claim **4** wherein a fourth of the five torque transmitting mechanisms is selectively engageable to interconnect the third member of the first planetary gear set and the second member of the second planetary gear set with the stationary member.

6. The transmission of claim **5** wherein a fifth of the five torque transmitting mechanisms is selectively engageable to interconnect the first member of the first planetary gear set with the stationary member.

7. The transmission of claim **1** wherein the first member of the first planetary gear set, the third member of the second planetary gear set and the third member of the third planetary gear set are sun gears, and the third member of the first planetary gear set, the first member of the second planetary gear set and the first member of the third planetary gear set are ring gears.

8. The transmission of claim **1** wherein two of the torque transmitting mechanisms are brakes for connecting a plurality of the first, second, and third members to the stationary member and three of the torque transmitting mechanisms are clutches for connecting at least one of the first, second, and third members of the first, second and third planetary gear sets to at least one other first, second and third members.

9. The transmission of claim **1** wherein the output member is continuously interconnected to the second member of the third planetary gear set.

* * * * *